Annex 52: Fuels for Efficiency

Project Duration	April 2015–March 2017
Participants **Task Sharing** **Cost Sharing**	Denmark, Finland, Israel, Thailand IEA Bioenergy Task 39 No cost sharing
Total Budget	€450,000 ($543,229 US)
Operating Agent	Padol Sukajit PTT Public Company Limited email: padol.s@pttplc.com

Purpose, Objectives, and Key Question

Annex 52, Fuels for Efficiency, was initiated in compliance with the global requirement to improve fuel efficiency for road transport fuel application. In general, automotive original equipment manufacturers (OEMs) try to improve their engines' efficiency while controlling the exhaust emission with regard to the country's requirement. The implication for advanced motor fuels, or the method for optimizing the fuels in order to maximize engine efficiency, has rarely been discussed worldwide.

Annex 52 intends to demonstrate how to optimize fuel with specific engines in terms of thermal efficiency gain, without any constraints on the format of fuel utilization, engine technology, or chemical additives. All members expect that the results will enable a new approach to automotive fuel optimization.

Activities

Annex 52 comprises a range of different experimental setups on various subtopics of improving fuel efficiency. Each has been designed according to the specific interests of the respective task-sharing participant:

- WP I: Information Exchange with IEA Bioenergy Task 39 (Survey on Advanced Fuels for Advanced Engines) and others (IEA-AMT)
- WP II: Performance Evaluation of Chemical Friction Modifiers for Diesel and Gasoline Fuels (Denmark)
- WP III: Fuel Reforming by Thermo-chemical Recuperation (Technion – Israel)

- WP IV: Performance Assessment of Various Paraffinic Diesel Fuels (Finland)
- WP V: Opportunity for Enhancing Fuels Efficiency by Ethanol-blended Gasoline Fuels (Thailand)

Key Findings

WP I: A survey on advanced fuels for advanced engines based on a review of the literature from the last 5 to 10 years mentions that the diversity of fuels will increase further on. New advanced fuels will be introduced in the market (e.g., BTL) or will be more in the focus of research activities (e.g., OME). The concept of drop-in fuel would be more user friendly for the new entrance into the market according to the available infrastructure. Furthermore, to achieve the mutual benefit between engine–fuel interaction, the new engine technique must be more flexible for a wide range of fuel. The megatrend on electric power will make broader use of biomass to electricity, while emissions are the major concern when using new fuel.

WP II: The experiment on performance evaluation of the chemical friction modifier additive for gasoline and diesel fuels proved that fuel economy improved. The result from gasoline engines shows that a 2.7% fuel efficiency improvement can be detected only at a specific condition, but overall test conditions resulted in only a slight percentage improvement. Cetane-improver additives seem to have an insignificant effect on fuel saving under all conditions. Thus, the effect of a chemical friction modifier in gasoline and the cetane improver in diesel fuel were not the promising solution for fuel efficiency improvement, at least for conventional engine technology.

WP III: The methane steam reformer improved fuel efficiency by 18% to 39% when running under the low- to medium-load condition. The major improvement comes from the wide flammability limit of hydrogen-rich fuel, which allows the engine to operate unthrottled, especially at low-load conditions or pumping losses reduction. In addition, the waste heat recovery from exhaust gas helps to maintain the endothermic reactions of methanol steam reforming (MSR). Thus, MSR is one of the major technologies for fuel efficiency improvement for a modified stationary gasoline engine.

WP IV: The aim of this project was to optimize non-road diesel engines for one paraffinic diesel fuel and compare the results with typical European-grade diesel fuel measured with OEM engine parameters. Optimization strategy was to increase the engine efficiency as high as possible without increasing emissions over the level defined with reference fuel and OEM engine parameters. Test fuel consisted of gas to liquid (GTL) and hydrotreated vegetable oil (HVO) from two sources and EN590 reference fuel (B7). The experiment was ongoing with the fully controllable diesel engine. The overall result showed the improvement in the engine efficiency for paraffinic fuels was in the range of 1.7%–2.0% (rel.) for NRSC and 1.1%–1.5% (rel.) for NRTC compared to reference fuel with OEM parameters. The key deliverable is all paraffinic diesels with low soot content have highly improved fuel efficiency, which allows modification of the fuel injection duration. Incidentally, the nitrogen oxides (NO_x) content is limited by emission regulations. Paraffinic diesel is one of the most promising fuels for modern diesel technology.

WP V: Ethanol-blended fuel has significantly improved fuel sensitivity (research octane number [RON] – motor octane number [MON]), which results in the possibility of higher engine output, if operated with the advance ignition timing feature. Since advanced ignition timing is a strategy used in modern Gasoline Direct Injection (GDI) engines, the use of ethanol-blended fuel is expected to improve the fuel efficiency of those engines. In this study, the experiment on research GDI engines was conducted to prove and determine the optimum ratio of ethanol blends (E0–E85) that engines could perform with high efficiency for GDI application by comparing the antiknock quality. The result is that E20–E85 blends have high potential for improving thermal efficiency in the range of 7%–17% compared to gasoline. Therefore, this benefit must use advanced ignition timing from ECU control, and an improvement in fuel efficiency can be achieved in modern gasoline GDI engines by using ethanol-blended fuel.

Publications

The final report is expected to be published soon; several technical publications will result from Annex 52.